DOCUMENT RESUME

ED 282 402 FL 016 687

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TITLE Talking Science: Content, Conflict, and Semantics.
PUB DATE [87]
NOTE 24p.
PUB TYPE Reports - Evaluative/Feasibility (142)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Concept Formation; Course Content; Discourse Analysis; English for Academic Purposes; *English for Science and Technology; Equal Education; Intellectual Disciplines; *Language Styles; *Sciences; Semantics; *Semiotics; Social Values; Sociolinguistics; *Specialization

ABSTRACT

One of the greatest obstacles to mastery of science and other analytical genres in school is excessive curricular emphasis on reading and hearing those genres without practice at speaking and writing them. In science, the curriculum tends to insure that only students with privileged social and linguistic backgrounds master the genre structures through which the thematic-semantic content of the subject is taught. Value conflicts between social groups and between technical elites and lay communities underlie the resistance of many students to mastering academic modes of discourse. To equalize educational opportunity between social groups, genre structures, content, and thematic formations shcuild be explicitly analyzed and taught in each academic discipline. (Author/MSE)

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ED282402

Talking Science: Content, Conflict, and Semantics

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Abstract:

A social semiotic model of discourse genres is presented and used to suggest that discourse mastery principally depends on learning genre organization and topic field semantics. Agegrade-specific performance is controlled by social limits on what is taught to whom and how. In the field of science, the curriculum tends to insure that only students with privileged social and linguistic backgrounds master the genre structures through which the thematic-semantic content of the subject is taught. Value conflicts between social groups, and between technical elites and lay communities, underlie the resistance of many students to mastering academic modes of discourse. The explicit analysis and teaching of genre structures and content thematic formations in each academic discipline is recommended to equalize educational opportunity between social groups.

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TALKING SCIENCE: CONTENT, CONFLICT, AND SEMANTICS

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Social semiotics and discourse development

Discourse resources may be described as a social semiotic system. Like other social semiotic resources, they provide means by which we make sense of and to one another. In the case of discourse, those means include:

(1) the social conventions for spoken and written genres,

(2) the socially typical patterns of semantic relations that create content meanings within some genre framework, and

(3) the characteristic context-dependencies and value-orientations of specific discourse formations in a community.

The study of discourse development has tended to emphasize how the formats for discourse organization (spoken and written genres) become habitual for individuals through their participation in social situations where these genres are in use. It is equally important to

understand the ways in which the semantic content of discourse is formulated within and through genres, and to recognize how the community regards the meanings produced in relation to the immediate context of a social situation and the wider contexts of social conflict over appropriate meanings. Social semiotics provides a theoretical framework for doing this (Halliday 1978; Lemke 1984, forthcoming). Its perspective on discourse development is that agegrade-specific discourse practices are those which a community implicitly or explicitly prescribes and provides for an agegrade.[1] Discourse maturation is taken to be totally under social control. Neurological maturation effects may very indirectly constrain the types of discourse practices a social group may prescribe for a given agegrade, but all the positive features of those practices, their typical chronological sequences, and the relations of the practices of different agegrades make sense primarily in terms of social relationships and social functions. The developmental sequence of discourse practices in a social group or community provides very little information about neurological development, but a great deal about social organization.

What discourse practices, then, <u>are</u> taught? How? To whom? And why? While these are questions for an entire research program, here I want to focus specifically on three issues:

= How can we describe the <u>thematic content</u> of discourse and the ways we are taught to deploy it through a genre form?

= What are the <u>genres</u> that are taught and neglected, especially for the discipline of science? and why?

= In what ways does value conflict over the form and content of science discourse manifest itself, and what are the social implications of these conflicts?

Learning to Talk Science

Classroom dialogue has its own characteristic genres, which tend to be much the same from one discipline to another, allowing for specialized variations and differences in the frequency of use of different genre patterns. The well-known three-part genre that consists minimally of teacher initiatives (mainly questions), student responses (mainly answers), and teacher evaluations is used by teachers and students in many subjects. How then do we distinguish questions and answers on science, from those in history, literature, or mathematics? That is, how do we formalize the content of these discourses? Of course it is true that particular contents sometimes have relatively fixed relations to particular genres, but by and large the same content can be expressed in many different genres. A relation of two scientific concepts may be expressed as a single declarative sentence in a monologic genre, or jointly by the sequence of question-answer-evaluation in a classroom dialogue. What differs are genre, social roles and relationships, and grammatical forms. But what remains the same?

What is the same is that the same semantic relations among equivalent semantic items are being constructed in both discourses.

Semantic relations, at least for the verbal component of discourse, are relations within the semiotic system of language. There has been a psychologistic tendency in non-linguistic discourse studies to ignore the enormous amount of foundational work on semantics and to substitute for precise linguistic relationships vague sets of so-called `cognitive' or `logical' relations, which derive from folk-linguistics, philosophical speculation, or formal logics (which are subsets of natural language, not meta-semiotics for it). If data is in the form of natural language, it is the linguistic semantics of that language which is the appropriate means for analyzing it. There is no evidence for a separate, independent semantics of `thought' (in words) apart from the semantics of language.[2]

The most complete work on the semantics of a natural language are Michael Halliday's studies of English grammar (Halliday 1975, 1978, 1982, 1985a, 1985b; Halliday and Hasan, 1976; Kress, 1976). While cautiously formulated in terms of the grammatical options for the expression of different possible meanings in English, the descriptive framework for the options necessarily reflects underlying semantic categories, and there is considerable evidence for common semantic distinctions and semantic relations across widely different functional domains of the grammar. The same semantic relations may also be realized through different grammatical patterns.[3] Halliday's model in effect says that whenever we set out to make a meaning using the linguistic resources of English, we make use of some rather than other specific semantic options available to us. Those options permeate the grammar of sentences, phrases, and word groups, and through succes-

sively finer and finer semantic distinctions bring us to specific word-choices. Above the level of the clause, in clause-complexes (including the now more precisely definable spoken analogue of the written sentence, see Halliday 1985b), and in genre structures, there are again similarly organized semantic distinctions with typical realizations in terms of structure. A working knowledge of these systems of semantic distinctions is essential for analyzing discourse in English.

A few years ago I undertook a large study of classroom communication of science (Lemke 1982, 1983b, 1985b, in-press (d)). One of the objectives of that study was to model the strategies by which the thematic content of classroom science was instantiated in the spoken discourse of teachers and students, and incidentally in written texts as well. This could only be properly done, however, when I could abstractly formulate the sets of semantic relations characteristic of a topic, and then observe how they were differently instantiated in different texts.[4] To speak the language of science, students, teachers, writers, and researchers must in effect map a non-linear set of topic-specific semantic relations onto linear genre- and grammatical structures. The sets of semantic relations can be represented in the form of weblike directed graphs (see example in the Appendix) in which nodes, representing thematic items, are connected by one or more arrows, representing semantic relations abstracted from Halliday's model. Each thematic item, which can itself be the designation of a whole web, is essentially an abstract category of its

possible synonyms, something like the name of a 'concept'. The whole representation is called a thematic formation.[5]

Fortunately for me, thematic formations in scientific and technical subjects are highly regular from one text or speaker to another, so it was quite easy to identify them and to abstract them from a small set of sample texts that make use of them. A real text will mix together a small number of thematic formations, and allude indirectly to a larger number (Lemke 1985a). Thematic formations are the representation in the semantic system of natural language of what is sometimes called 'knowledge-of-the-world'. It is 'knowledge' of course only with respect to some individual whose discourse (or more generally whose action) makes use of it. But thematic formations are not characteristics of speakers as such. Like genres, they are characteristic of speech communities, and they have social functions and social relations, not only to their contexts of use, but to other thematic formations as well (e.g. those which formulate the same topic in different, and perhaps opposed ways). Teaching science is teaching the use of specific thematic formations in discourse (and analogous actional formations for nondiscursive, socially meaningful behavior[6]). It is also, necessarily, teaching the appropriate discourse genres.

Science and Discourse Genres

The genres of science are specializations and variations of genre types that share features across disciplines, undoubtedly because they

descend from common ancestors (cf. Foucault 1966). The genres of Description (of objects, events, and processes), Comparison, Definition, Classification, Argument-from-evidence, Explanation, and Exposition are certainly of this sort. More specialized genres like the Experimental Research Report, or the Laboratory Notebook, also have their histories and their origins in older genres. Some of these genres are mainly written, others may also be spoken, or have spoken variations. Still other science genres are implicitly parts of action structures which include non-discursive practices (e.g. Measurement, Observation) or practices which are discursive, but not necessarily entirely verbal (e.g. pencil-and-paper Problem Solving).

To learn the genres specific to science, it helps to have already mastered kindred genres. The spoken genres of the home may, depending on social class, resemble those of the school, including those of the science curriculum, more or less closely (cf. Heath 1983). Particular subcultures may use alternative genres for the same functions (e.g. reporting experiences, giving explanations, glossing meanings, describing objects, etc.) These may conflict with those that the curriculum requires. There does not seem to be adequate research on the functional genres of different agegrades, especially in non-school contexts. How do 3 or 4 year-olds, in urban working-class ethnic communities, formulate descriptions, explanations, comparisons, etc.? How about upper middle-class suburban 10 year-olds? in school, in play, in conversation with parents, etc.? Naturalistic observation is clearly important to defining the contexts which can call forth a genre. All language genres are ultimately constituents of action

structures that are specific to situation types. What is called forth in an artificially constructed situation may have no reliable connection to performance in familiar contexts.

The mastery of written genres is certainly made easier if we are accustomed to using a similar spoken genre. The fundamental differences of spoken and written language must be taken into account in helping students adapt the one to the other (cf. Halliday 1985b). In science, as in many other academic subjects, the written genres are the only ones to have prestige, recognition, or explicit formulation. It may even be true to some degree that the spoken genres are derived from the written ones today, or that their norms at least follow those of the written register (though historically it was probably the other way around). This means, however, that we lack explicit formulations of the spoken developmental precursors to written genres. That in turn means that we cannot and do not explicitly teach the spoken genres, thus insuring that students from backgrounds where the precursors, or close analogues of them, are in use will have an enormous advantage in learning the written genres. We lack a curriculum to provide these missing skills to students from other backgrounds, as we largely lack a curriculum for all students that explicitly teaches these genres, spoken or written (cf. discussion in Lemke, in-press (b)).

In developmental perspective, our community, through its historically evolved curriculum, tends to teach particular genres to particular agegrades. It is especially notable that even the precursors of the written genres which we would tend to identify as the genres of power, including written scientific, academic, and bureaucratic-

technical genres, are scarcely taught at all to earlier agegrades, certainly in the first several years of schooling. In those years what we do teach is mainly the written genre of Narrative (Martin, 1985). In other societies, power may be exercised through narrative, but this does not seem to be so in the dominant subcultures of our own. It seems a reasonable hypothesis that the curriculum defers teaching these genres until education's social sorting functions have insured that the power confered by mastery of these genres will largely wind up in the hands of those with the `right' backgrounds and attitudes. This principle seems to hold in the large from elementary to postgraduate education. The rationalizations for it are many. Some hold that earlier agegrades are not `ready' for these genres, though this is hard to accept since we know that the complexity of narrative structures is easily as great as that of the genres in question. Others argue that teaching these genres would rob childhood of its innocence, that it is somehow inappropriate (frightening?) that children should use written language to analyze the world around them instead of merely to tell unthreatening, or at least unreal (to adults) stories.

One of the greatest obstacles placed in the way of mastery of science and other analytical genres in school is the excessive curricular emphasis on reading and hearing these genres without practice at speaking and writing them. If foreign language teaching were still conducted according to this principle, Americans would be kept even more ignorant of the world at large than they now are. Indeed, most Americans <u>are</u> quite effectively kept ignorant of anything more

than the mystique of science (cf. Lemke, in-press (e)). Moreover, lack of mastery of the genres of science also effectively insures that students will have enormous difficulty mastering its thematic formations, which are presented and used, for the most part, only through these genres, though in principle they could also be realized in the form of stories, dramatic dialogues, humorous anecdotes, etc.[7] In a developmental perspective, we need to notice that we teach earlier agegrades genres in which we do not instantiate the thematic formations of science (or most academic knowledge), and we then teach these formations a few years later through genres we must expect the students have learned on their own. Only those who succeed at this become eligible to be taught the appropriate formal academic genres (much later, e.g. in college composition courses). One can scarcely imagine a system better designed to maximize social class advantages, while giving the appearance of offering an equal opportunity to all.

Discourse conflict and social conflict

If we accept a model in which people learn to talk science, or any other subject, largely by following the relatively standardized semantic patterns represented by thematic formations, then it is particularly important to consider how a community manages discourse diversity. While any one thematic formation will be used in much the same terms by many speakers and writers on many occasions, within a given subject field or topic, the diversity of social groups and

interests insures that there will often be more than one alternative formation in use in the community. These may be competing scientific theories or models, complementary points of view on a topic, etc. Each group in a community tends not only to use a particular subset of the available alternatives, and to use them in specific contexts, but also to have a definite value-orientation toward 'its own' and toward other formations. Frequently, if the discourse of a given subject is highly polarized, groups will regard their own thematic formation as right, correct, or appropriate, and those of other groups as wrong-headed or worse. This phenomenon of discourse diversity is known as heteroglossia (Bakhtin 1935; Lemke in-press (a), (c), and forthcoming). Every member of a community, by virtue of their social positioning within it, will hear, speak, read, and write every linguistic meaning against the background of heteroglossic diversity, and especially heteroglossic oppositions and conflicts. These conflicts, of course, are not merely semantic; they embody social conflicts of practices and interests that may be more broadly economic, political, religious, and professional as well as discursive.

In my studies of science classroom discourse, it is apparent that the thematics used by students are not always the same as those used by the teacher. The teacher's thematic formations tend to closely resemble those of the textbook, or of university and research science (though they are not precisely the same), with an admixture of the thematics of everyday experience. Students tend more to use commonsense ideas, with much less of the formal thematics of science.

In this state of affairs two principal kinds of heteroglossic conflict are seen. First, there are the classroom episodes in which students and teachers disagree and debate a question of science, each using the discourse of a thematic formation not fully available to the other.[8] For example, teachers frequently misunderstand students' points, because of the unfamiliar semantic patterns in which those points are expressed. Moreover, clarification requires at least that the teacher know how his thematic formation and that of the students disagree. The social heteroglossia here is that between the language of teachers and the language of students. Both teachers and students must learn to speak both languages, or at least to interpret both. The ideology of authority, however, stands in the way. Teachers and students are not just taught to speak particular formations, but they learn to believe that their own formations are the ones that are 'right' or make 'sense' and to deprecate others. When teachers and students also come from very different social groups, the antagonism of the groups' value-orientations toward one another tend to exaggerate this discourse intolerance. In science one can observe this for male teachers vs. female students, for middle-class teachers vs. lower-class students, for white teachers vs black students, etc. In each case, the chances are reduced that both sides will extend the benefit of the doubt to the other sufficiently to allow them to understand that the other is speaking a different thematics, rather than no meaningful thematics at all.

These discourse conflicts tend to lie within or to be exaggerated by a more global one: that between the discourse of science and all

its thematic formations on the one hand and the discourse of commonsense language and its formations on the other. There is not just a difference here, there is a perceived and promoted antagonism.[9] Science teachers, science journalists, and scientists themselves constantly emphasize the unreliability of commonsense perceptions and expectations, and the counter-intuitive nature of scientific insights. This is often done in a 'tolerant' way that only emphasizes that the nonscientist cannot be expected to see things as the scientist does, but with the clear implication of the superiority, indeed the sole correctness of the scientific point-of-view. That point-of-view, while it is constituted by practices of many kinds, can be adequately represented for most purposes by its thematic formations. We can then be in a position to highlight its differences from commonsense formations. That selective attention to differences, of course, must itself be done from some point-of-view, either that of the analyst's interests and practices, or one of those commonly available in the community. In any case, there will be a discursive construction of the relationship between formations. Such relationships are always made, not found. And more often than not the relationships made are not value-neutral, but value one formation above the other, or value one positively, the other negatively. In another study, I have shown how substantially the same formation is positively valued and allied to the writer's point-of-view in each of two texts that strongly oppose one another (Lemke, in-press (a)). Interestingly, the debate in these texts, on opposite sides of the issue of Gay Rights, hinges in large part on creating alliances between their special viewpoints and a

thematic formation they take to be an `objective' scientific one (Biology, Psychology, Medicine, etc.). The warrant of `objective truth' in the ideology of the sciences is not only a bid for intellectual hegemony on the part of scientific discourse, it is also the basis for technocratic claims to power. Thus scientific discourse, long in conflict with humanistic, artistic, and religious formations (not only over `truth', but over intellectual primacy), is now also frequently in political conflict with claims for policy decisions based on other principles (e.g. justice, moral values). [10]

Discourse formations are shaped by their uses. The conflicts which the community orchestrates among them (in general, their heteroglossic relations) are an integral part of the conflicts of interest among groups in the community defined by their social practices: by the work they do, the ways they talk, what they prefer, etc.[11] Teachers have interests that conflict with those of students. Scientists have interests that conflict with those of nonscientists. Adults have interest conflicts with children; middle-class adults with working-class adults, etc. The discourses of science that are taught in the classroom favor some of those interests over others.

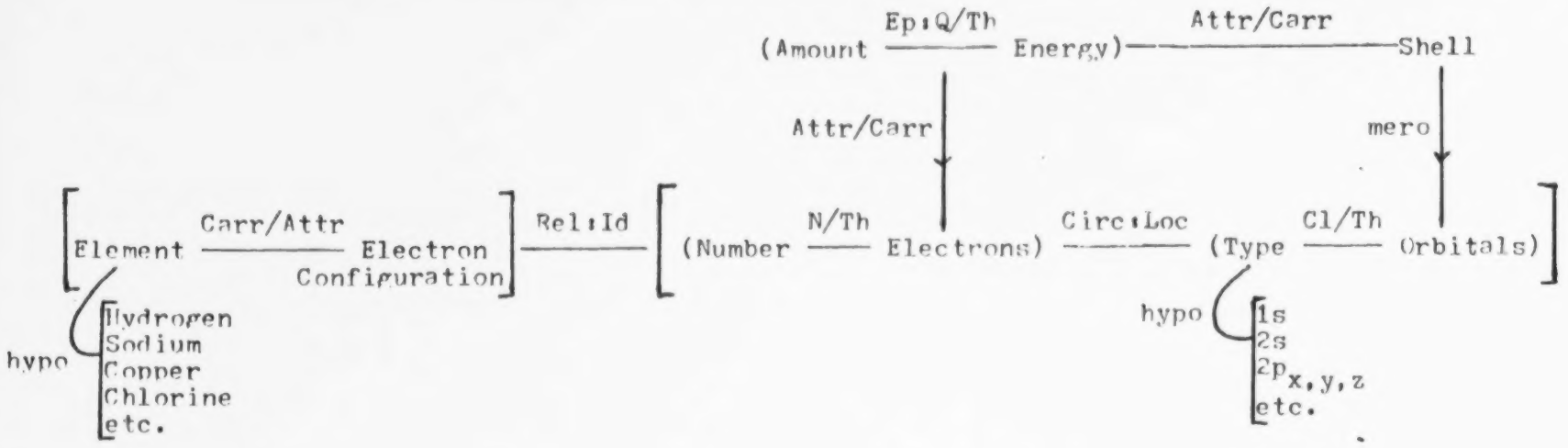
Scientific discourse in general favors a small educated elite over the general population. It is written and spoken, and taught, in ways that make it relatively inaccessible. It tries to tells us that it is <u>intrinsically</u> more difficult to master it than other discourses, that it requires a special kind of intelligence, that only the superior are capable of mastering it. It convinces most people exposed to its myths that it is their own inferiority which keeps them from

understanding it, and/or that it is not something they would want to master (because it is so cold, impersonal, and un-humanistic). By encouraging this self-exclusion, and by excluding subtly from its available channels of transmission all those who do not have certain specialized discourse prerequisites, it succeeds in perpetuating an elite.[12] From the viewpoint of social semiotics, no discourse formation can possibly be more or less difficult to master than any other, intrinsically. It can be so only by virtue of (1) prior mastery of other formations which are closely related thematically, structurally, or practically, and (2) participation in the practical contexts of use of a formation.[13] The effects of these exclusions tend to favor the interests of males over females, whites over nonwhites (except some Asians), middle- and upper middle-class over lower working-class, and native English speakers and standard dialect speakers over others.

Discourse mastery is taught, or made to seem to be taught, formation by formation. Every formation is embedded in a network of socially constructed relationships, especially value relationships and alliances or conflicts, which is also -- most often implicitly -- taught, and which equally needs to be mastered to use the formation in real social contexts. Education by and large tends to ignore the explicit teaching of discourse formations and their social relationships and functions. Instead, it propagates the myths of 'knowers and knowledge' in place of speakers and discourses, of 'intelligence' in place of discourse fluency (and generally, of action-formation skill). It endorses the 'objectivity of knowledge' to the neglect of setting each discourse in relation to other discourses. All this it does to

the benefit of the fewest number and against the interests of social justice. In science education, and in every discipline, those of us who use discourse perspectives need to say these things to all educators, and to demonstrate positive alternatives.

APPENDIX: Simple Thematic Formation Diagram



Carr/Attr, Carrier/Attribute
Circ:Loc, Carrier/Attribute:Circumstance:Location
Rel:Id, Relational:identifying: defining
Cl/Th, Classifier/Thing
N/Th, Numerative/Thing
Ep:Q/Th, Epithet:Quantity/Thing
hypo, Hyponymy (class/member)
mero, Meronymy (whole/part)

FIGURE 1

Endnotes

[1]I use the term 'agegrade' rather than 'age' because it is a socially defined category of persons, not the elapsed clocktime since birth or conception, to which a set of discourse practices is specific. Agegrades typically span a range of ages, and other factors than age may be relevant to its social construction.

[2]See Lemke (in press, b). When we need to go beyond language to include pictorial and other semiotic systems, it is again their analogues of semantics which are relevant. The question of whether and to what extent different semiotic systems share a common metasemantics is unanswerable at present. Psychologistic speculation on this is absurdly premature since it is neither based on examination of independent semiotic systems, nor do its hypotheses agree with the known semantics of natural language. See Halliday 1978, 1985.

[3]See Halliday (1985a), pp. 306-307, and chapter 10. His recent, still unpublished paper, "The ineffability of grammatical categories," further develops these themes.

[4]From here on 'text' will mean spoken as well as written language productions.

[5]See Lemke, 1983a (where thematic 'system' was used for 'formation') and also Lemke, in press (a) and in press (c).

[6]For the generalization from discourse to action, see Lemke 1984 and Forthcoming.

[7]Rhetorical, stylistic, and genre norms of classroom science discourse are discussed in Lemke (1983b), Chaps. 4 and 5.

[8]Examples will be found in Lemke 1983b and (forthcoming).

[9]These issues are discussed in detail in Lemke 1983, chap. 4, and in Lemke (forthcoming).

[10]These issues are further discussed in Lemke (1987).

[11]The notion that social groups should be defined by how their customary social practices situate them in relation to other groups is developed in Bourdieu (1979) and Lemke (forthcoming).

[12]Those prerequisites usually include native English, standard dialect, and certain middle-class speech genres. Cf. Heath (1983).

[13]See Lemke (1985a), where thematic, generic-structural, and actional (practical activity) relationships of formations are defined. The discourse formations used in schools to teach a formation have an actional relation to those formations that are taught through them.

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